Space Weather Technical Forecast

Issued on Monday 10 February 2025 at 13:14 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of M-class flares (R1-R2 Blackouts). Chance of G1/Minor throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with peak flare M1.0 from AR3981 in the northwest disc. This region is becoming more difficult to assess as it rotates over the northwest limb, but continues to give a chance of flaring with some visible looping evident above the spot in SDO imagery. There are a total of seven region currently on the disc, with the other regions largely small and simple. The main exception is potentially newly numbered AR3990 in the southeast, although this is also difficult to assess due to its proximity to the southeast limb.

No Earth directed Coronal Mass Ejections (CMEs) were observed from available imagery.

Solar Wind / Geomagnetic Activity: Solar winds showed the onset of a fast wind from CH14/-. Background solar winds were initially 400km/s before steadily increasing to reach elevated, 550-600 km/s, by 09/1800 UTC. Density was near normal, but eased to be below average. Interplanetary Magnetic Field, Bt, was initially Strong 12-20nT, before easing to be Weak at 6-8nT from 10/0030 UTC. North-south component, Bz, was turbulent, but favouring a southward orientation, ranging -16nT to +10nT. This eased to range -7nT to +7nT from 10/0030 UTC. Phi angle was negative (towards the Sun). Geomagnetic activity was Unsettled to Active (Kp3-4), with two G1/Minor Storms intervals observed (09/1800-2100 UTC and 10/0000-0300 UTC), although these were initially reported as Active intervals.

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 remained at background. High energy electron flux (greater than 2MeV) at GOES16 was at mostly background with a brief peak of 334 pppc at 09/1320 UTC. The associated 24-hour fluence persisted below the Active threshold, recording 2.96e6 integrated pfu at 10/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is likely with isolated M-class flares and a very slight chance of X-class flares.

Solar Wind / Geomagnetic Activity: There is a slight chance of two glancing CMEs during Days 1 or 2 (10-11 Feb). Otherwise ongoing fast wind influence from CH13/- is expected, before transitioning into the fast wind from CH14/- on days 3-4 (12-13 Feb). Quiet to Active geomagnetic

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activity is forecast with G1 Minor Storms likely and a slight chance G2 Moderate Storm from any CME arrival Day 1-2 (10-11 Feb), and an ongoing chance of G1 Minor Storms day 3-4 (12-13 Feb).

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 is forecast to persist at background with only a slight chance of rising due to any notable flares from AR3981 in the northeast. High energy electron flux observed at GOES16 is expected to see a gradual rising trend later in the period, with an increasing chance of periods of High flux. The associated 24 hour fluence is currently expected to remain below Active, but with a likely rising trend.

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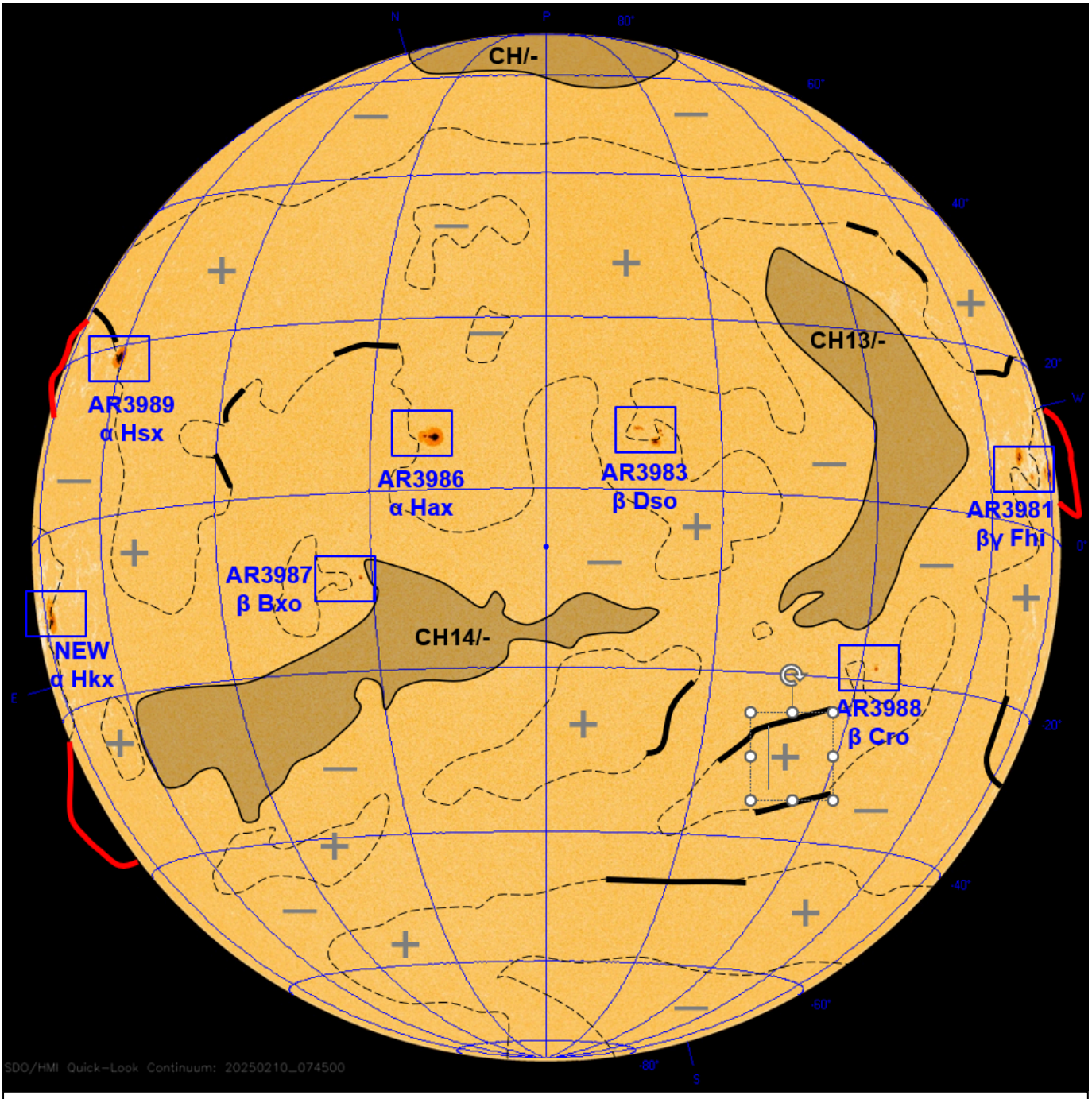
Figure 1: MOSWOC Solar Synoptic Map 10/0800 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There is a slight chance of up to two glancing blows from faint CMEs associated with two M7 flares on 06/07 Feb, which may arrive at Earth late on Day 1 (10 Feb) and into the early hours of Day 2 (11 Feb). A third slow CME left the Sun around 08/0930 UTC in association with the M2.0 flare from AR3981. This is considered most likely to miss, passing ahead of Earth, but cannot be completely ruled out for a glancing enhancement on Day 4 (13 Feb).

Ongoing fast wind from CH13/- is expected Day 1-2 (10-11 Feb) with solar winds likely elevated, perhaps easing to be slightly elevated during day 2 (450km/s). The next enhancement is then expected later day 3 or day 4, (12-13 Feb), with connection to CH14/-. This is an elongated feature across a similar latitude to Earths current heliographic projection, but has seen its western extent reduced in size compared to previous rotation. Any subsequent enhancement from this feature is low confidence in terms of the timing of onset, but is likely to become Elevated to Strong (500-600km/s) by the end of the period. This is largely supported by MOSWOC Enlil with persistent solar winds of around 550-600km/s from later on day 2 (11 Feb), albeit with a slightly early onset.

Quiet to Active (Kp 2-4) geomagnetic activity through the period due to ongoing slightly elevated to elevated solar winds. G1/Minor storm (Kp 5) intervals are likely at first, with a slight chance of G2/Moderate storm intervals (Kp 6) if any CME influence is observed. There is also an ongoing chance of G1 Minor storms day 2-4 (11-13 Feb) from any further fast wind enhancement or CME glance, most likely if they give a combine influence however this is low confidence.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	70	50	50	50
Strong	G3	No	1	5	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
07/0200	Partial	AR3981	NW	300	10/2100 +/-12 hours	Low confidence.
07/2100	Partial	AR3981	NW	300	11/0000 +/-12 hours	Low confidence.

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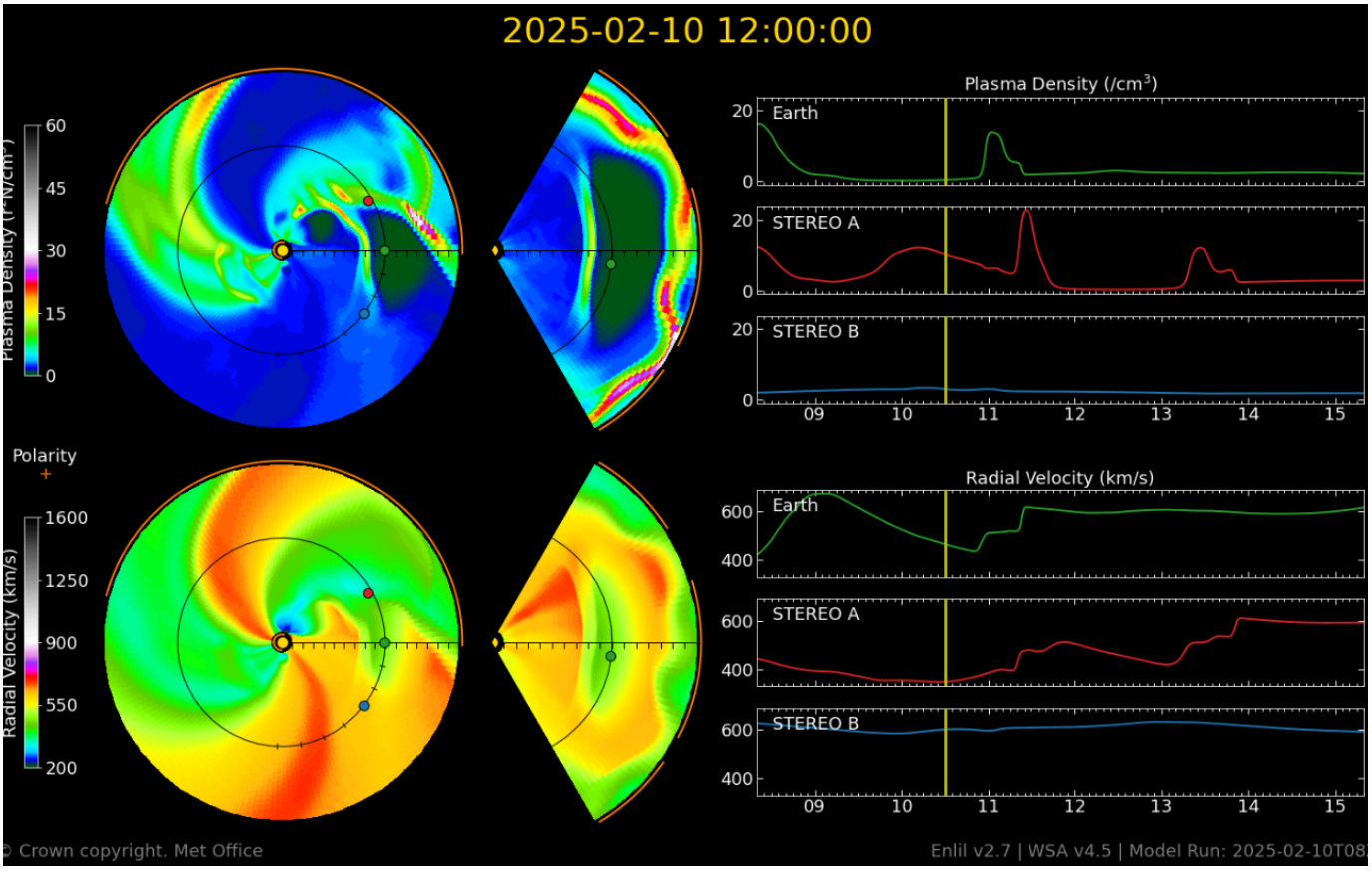
Figure 2: MOSWOC Enlil showing weak CME glances



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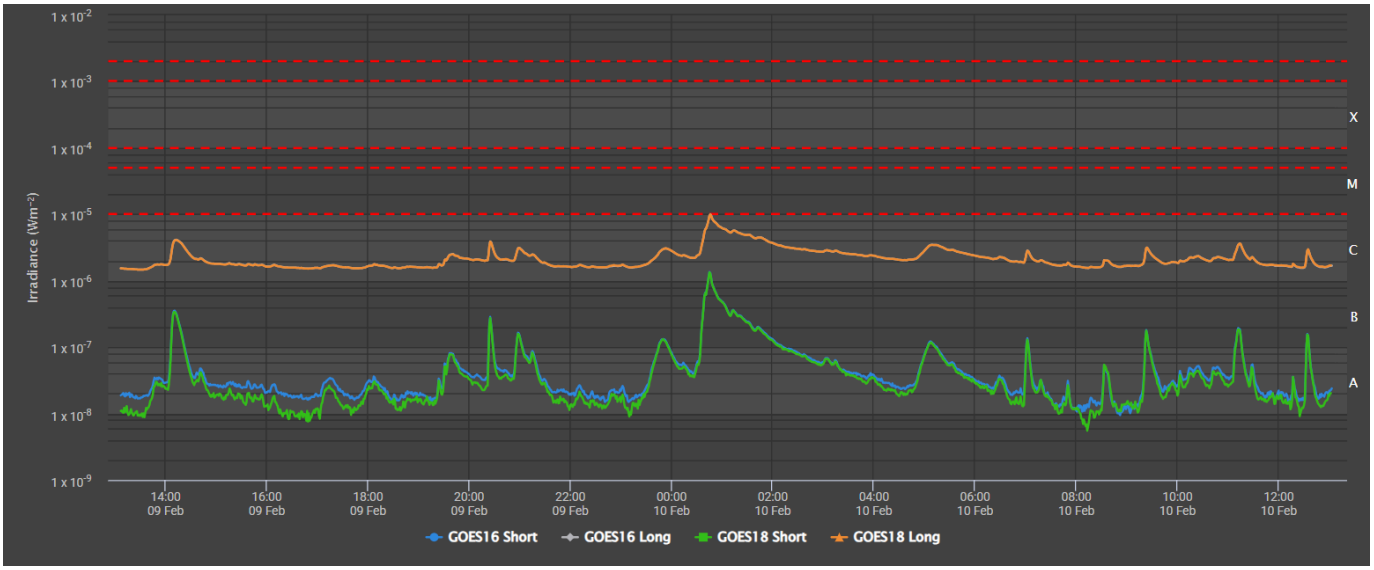
Radio Blackouts - X-Ray Flares

Moderate activity is likely with isolated M-flares and an ongoing slight chance of isolated X-class flares. These are most likely from AR3981 in the northwest disc, or the new region in the southeast which has now been numbered AR3990.

AR3981, which has been the most active region in recent times is currently rotating off the northwest disc, with analysis becoming increasingly difficult. There is some bright magnetic looping evident above the spot in e.g. SDO aia-94, suggesting an ongoing flare potential, however this risk will recede as this moves over the limb through day 2 (11 Feb). The other regions across the disc are mostly smaller and simpler, however AR3981 in the southeast disc has the potential for further complexity to become visible as this moves into a less oblique viewing angle. This is currently a large unipolar spot, but has shown some activity on the far-side.

X-Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 (M Class)	Yes	60	60	60	60
Very Active	R3-R5 (X Class)	No	5	5	5	5

Figure 3: GOES 16/18 X-ray Irradiance



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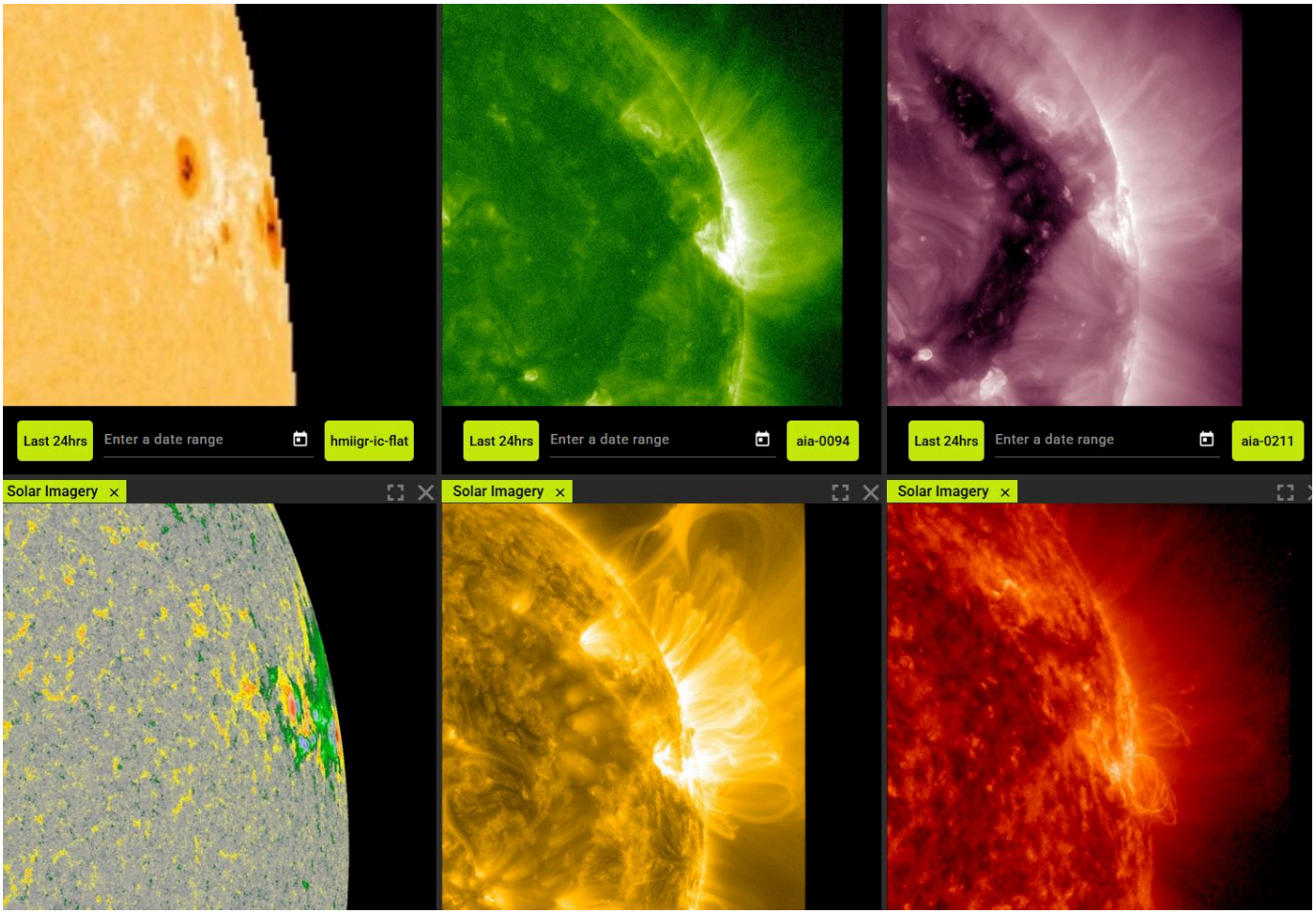
Solar Radiation Storms (High Energy Protons)

GOES-16 proton flux is forecast to persist at background with only a very slight chance of enhancement from any notable flares. This is most likely from AR3981 in the northwest, along with the other sunspots that previously rotated over the limb, however this has shown some sign of simplification in the last few days limiting this potential.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	5
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: SDO imagery of AR3981 on northwest disc.



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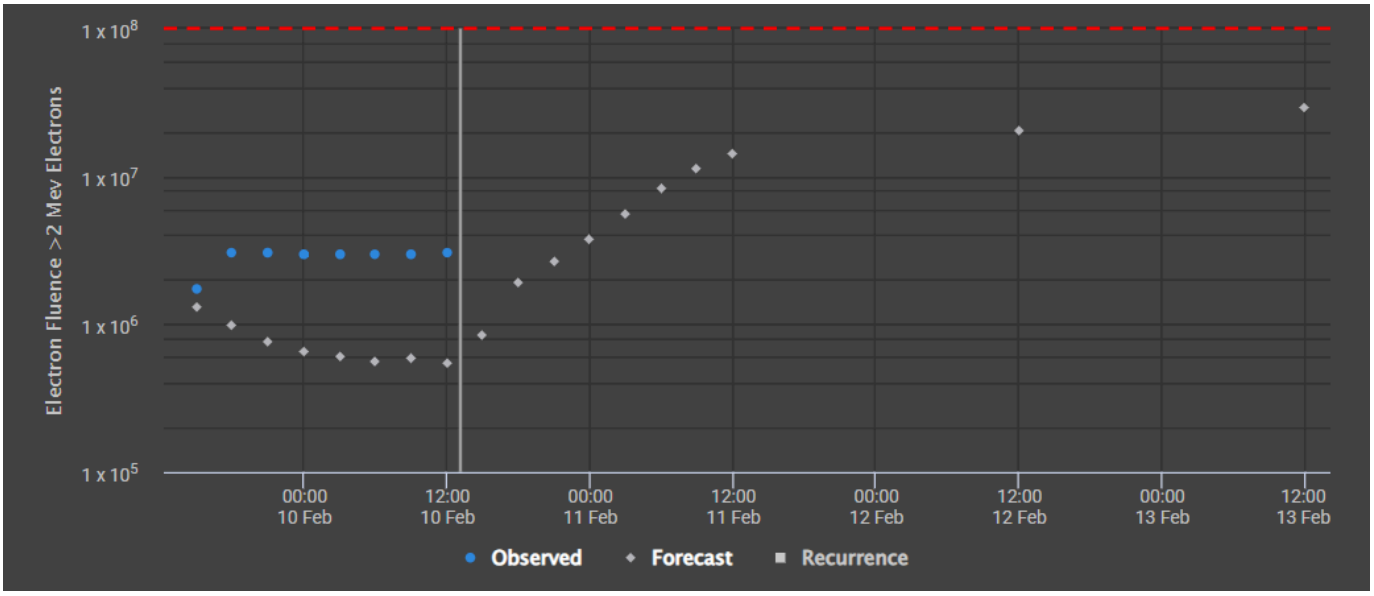
High Energy Electrons (≥ 2MeV)

High energy electron flux observed at GOES16 has been Background to Moderate and expected to continue mostly at this level. The arrival of the High Speed stream (HSS) from CH13/-, is likely to give an eventual response in the observed flux, due to charging of the outer Van-Allen belt. Possible CME arrivals, along with a further enhancement from CH14/- complicate this picture, perhaps limiting any potential rise until later in this period. This brings an increasing likelihood of periods of High flux at diurnal peak from day 2 (11 Feb)

The corresponding 24-hour fluence is expected to be below the Active threshold, but with a rising trend probable. While this is supported by MOSWOC REFM, this is perhaps under-forecasting the potential rise later in the period.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	5	5	10
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 5: GOES 16 >2 MeV electron fluence with REFM



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